Fishery Data Series Number 97-2

Age Distribution of Chinook Salmon Escapement Samples, Togiak National Wildlife Refuge, Alaska, 1992 - 1996

Rob MacDonald
Biological Technician, Fisheries

March 1997

United States Department of the Interior
Fish and Wildlife Service
Togiak National Wildlife Refuge

Fishery Data Series Number 97-2

Age Distribution of Chinook Salmon Escapement Samples, Togiak National Wildlife Refuge, Alaska, 1992 - 1996

Rob MacDonald
Biological Technician, Fisheries

Keywords: chinook salmon, escapement, Arolik River, Gechiak Creek, North Fork Goodnews River, Kanektok River, Matogak River, Osviak River, Pungokepuk Creek, Togiak River, Togiak National Wildlife Refuge, southwest Alaska

Togiak National Wildlife Refuge
U.S. Fish and Wildlife Service
P.O. Box 270
Dillingham, Alaska 99576
(907) 842-1063

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Fishery Data Series Number 97-2

Age Distribution of Chinook Salmon Escapement Samples, Togiak National Wildlife Refuge, Alaska, 1992 - 1996

ABSTRACT - Age, sex and length sampling of chinook salmon (Oncorhynchus tshawytscha) escapement was conducted by U.S. Fish and Wildlife Service field crews on eight creeks and rivers within the Togiak National Wildlife Refuge (Refuge). A total of 1,898 chinook salmon carcasses were sampled. Scale impressions were used to determine fish ages. Nine different age designations were determined ranging from age 1.1 to 2.4. Most fish sampled lived one winter in fresh water after hatching. After outmigration most chinook salmon from these systems spent 4 years in the ocean environment before returning to spawn in their 6th year (age 1.4). Age 1.3 chinook salmon also represented a large portion of the sample. Maximum ages observed were 1.5 and 2.4.

Although these are relatively small sample sizes for most rivers, this collection of chinook salmon escapement samples provides the only recent published age, sex and length composition data for Refuge waters.

INTRODUCTION

The Togiak National Wildlife Refuge encompasses approximately 4.3 million acres in southwest Alaska (Figure 1). Fourteen drainages ranging in area from 130 to 5,200 km^2 (50 to 2,000 mi^2) flow from the Refuge into Bristol and Kuskokwim Bays. Each drainage terminus is located in one of four commercial fishery management districts. One of the primary objectives of the Refuge is to conserve fish and wildlife populations and habitat in their natural diversity.

Although the Alaska Department of Fish and Game (ADFG) has primary management authority over commercial fisheries activities to ensure an adequate spawning escapement, the U.S. Fish and Wildlife Service (Service) works cooperatively with ADFG in collecting pertinent data which can assist in better management. In order to monitor long term health of individual salmon runs, forecast future runs, or evaluate escapement goals, it is necessary to sample both the harvest and spawning escapement.

The Alaska Department of Fish and Game samples commercial catches of chinook, sockeye (O. nerka), chum (O. keta) and coho (O. kisutch) salmon from the main commercial fishing districts (Quinhagak, Goodnews, Togiak, and Nushagak) along the Refuge coastline. Currently the Department collects escapement samples only from sockeye salmon in Togiak and Amanka Lakes, and from four salmon species migrating through the fish weir on the Middle Fork of the Goodnews River. Increasing budget restraints over the last ten years have eliminated all other chinook salmon escapement sampling programs ADFG conducted within the Refuge. Over the past several years the Service has tried to collect age, sex and length (ASL) data from chinook

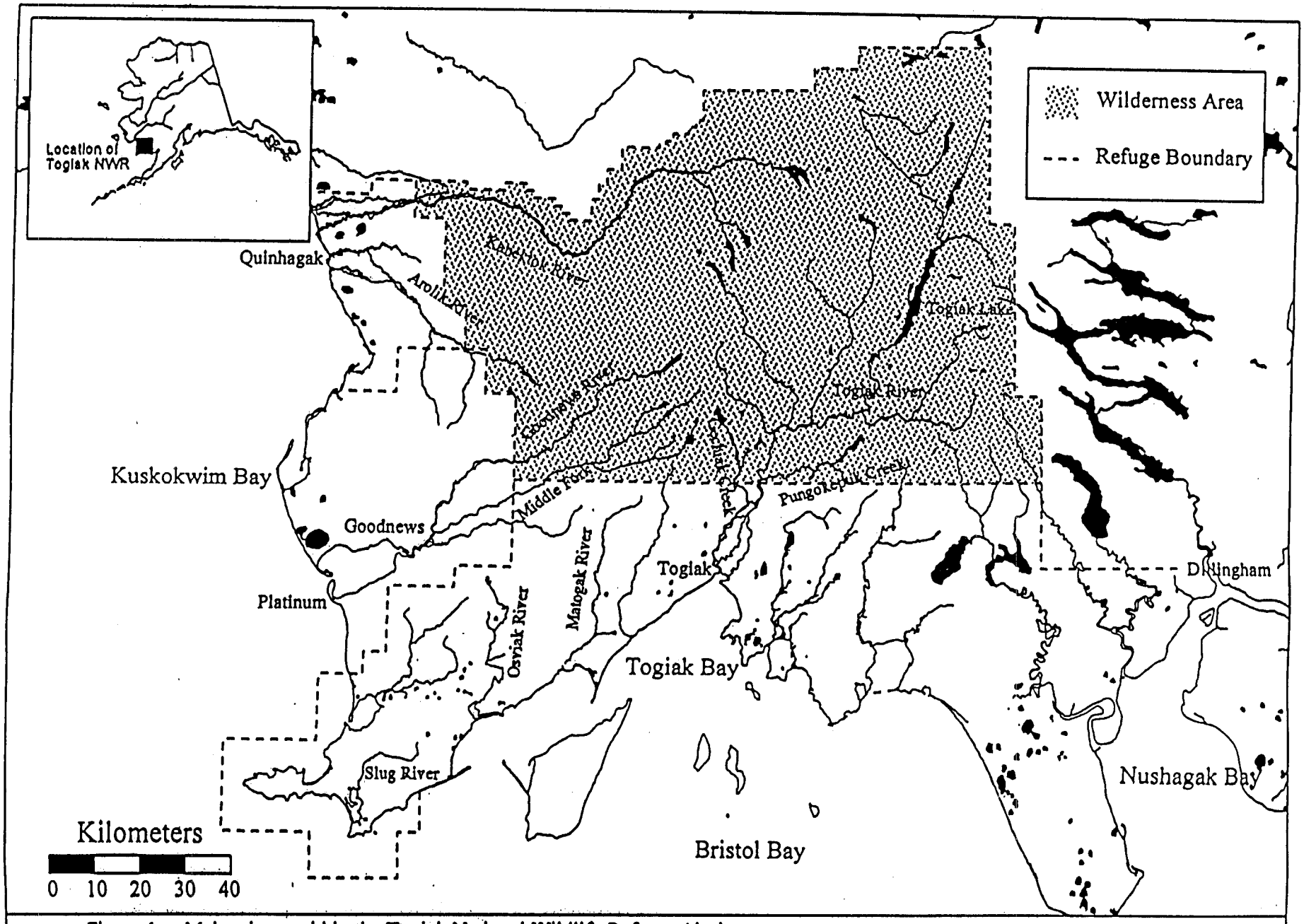

Figure 1. Major rivers within the Togiak National Wildlife Refuge, Alaska.

salmon in the Refuge's three main river systems (Togiak, Kanektok and Goodnews Rivers). An increase in the Service's presence on the major waterways within the Refuge due to fisheries inventories and public use management programs has allowed the collection of ASL samples from chinook salmon carcasses in a cost-effective manner.

Chinook salmon escapement was sampled in 1992 (N = 483), 1993 (N = 256), 1994 (N = 624), 1995 (N = 263), and 1996 (N = 272). Samples were collected from the Arolik, North Fork Goodnews, Kanektok, Matogak, Osviak and Togiak Rivers and from Gechiak and Pungokepuk Creeks (Figure 1). Previously the chinook salmon escapement data from 1994 (Lisac and MacDonald 1995) and 1995 (MacDonald 1996) were published in Fishery Data Series Reports. This report documents data collected from 1992, 1993, and 1996 and adds the 1994 and 1995 data for comparison. Samples were gathered on an opportunistic basis from the entire river unless specific tributaries are identified.

The objectives of this report are to:

1. Document the age, sex and length composition of the escapement component of chinook salmon returns to Refuge rivers targeted by commercial fisheries.

2. Compile this data on an annual basis and make available to resource managers in a standard format archived in the State Research and Technical Services (RTS) system.

METHODS

Refuge personnel participating in resident fish inventories or public use surveys sampled chinook salmon carcasses encountered along various rivers (MacDonald 1996). The time period between 1 - 20 August has been identified as the most likely time period for chinook salmon carcasses to be available. During annual seasonal staff training and orientation, field crews are taught correct scale collection, length measurement, and recording techniques. A target of 460 chinook escapement samples from each drainage is desired (Cindy Anderson, personal communication).

Standard age, sex and length sampling as outlined in Clutter and Whitesel (1956) are followed. Lengths are measured from mid-eye to fork of tail and recorded to the nearest millimeter. Scales are collected on gum cards or in coin envelopes with the data being directly recorded on ADFG Standard Age Weight Length Mark-Sense Data Forms (Version 1.1) or transferred from coin envelopes at a later date (ADFG 1990). Data forms are sent to ADFG Research and Technical Services for optical scanning. Each data set is assigned a file number which corresponds to the State fisheries management area, the species sampled, and the year of collection. Electronic data files are on file with ADFG and the Refuge. Frequency reports are generated which tally data by field and allow data validation and editing using WordPerfect software (Heineman 1989a).

Acetate impressions are made of scales using a hydraulic press (Dery 1983 and Riffe 1994). All

scales are aged using a Canon PC 70M microfiche copier with a forty-power lens via methods outlined in Mosher (1969) and Lux (undated). Ages are reported using the European system of age designation. The number of winters the fish spent in fresh water (not counting the winter the egg was in the gravel) is shown as an Arabic numeral followed by a dot, then the number of winters the fish spent in the ocean. Therefore, a salmon of age 1.3 spent 1 winter in fresh water after hatching and 3 winters in the ocean; the fish is four years old and is in its fifth year when it returns to spawn (Mosher 1969). The scale reader made three independent age determinations for each scale sample. The mean modal age is reported as suggested by Coggins (1994). Samples with no modal age are treated as unreadable.

Completed data sets are analyzed using the crosstabulation program BBXPEXE, developed by ADFG's Research and Technical Services (Heineman 1989b). The BBXPEXE program produces unweighted estimates of mean length and percentage by age group, and the associated standard error estimates following procedures outlined by Sokal and Rohlf (1981, Boxes 4.2 and 7.1, pages 56 and 139) (Riffe 1994). Summary tables of results for rivers with a sample size greater than 20 are presented here as Tables 1-5. Rivers with sample sizes less than 20 fish are provided in narrative form only.

RESULTS

Scale samples, sex determinations, and lengths were collected from 1,898 chinook salmon in eight creeks and rivers within the Togiak National Wildlife Refuge. Most samples were collected from the Kanektok River (1,164), followed by the North Fork Goodnews River (510), Togiak River (115), Arolik River (77), Gechiak Creek (23), Osviak River (4), Matogak River (3), and Pungokepuk Creek (2) (Appendix A). Ages were determined for 1,518 samples. The rest (380) had scales that were regenerated or rejected as unreadable. Twenty-five of these samples were aged but either did not have a corresponding sex determination or length measurement and are not included in the sample. Refuge River Rangers and a creel survey crew collected all samples from the Kanektok, North Fork Goodnews, and Togiak Rivers. Refuge fisheries personnel collected all samples from the Arolik, Matogak, and Osviak Rivers and from Gechiak and Pungokepuk Creeks.

Summary tables present the age distribution and mean length by age group and sex for Gechiak Creek and the Arolik, North Fork Goodnews, Kanektok, and Togiak Rivers (Tables 1-5). Sample sizes from Pungokepuk Creek and the Matogak and Osviak Rivers were small and a summary of these collections is provided in narrative form only.

The Matogak River was sampled from 20 to 21 August 1996. All three chinook salmon carcasses sampled were females. Two were age 1.3 (mean length 816 mm) and one was age 1.4 (length 820 mm).

Table 1. Mean lengths (mm) of chinook salmon by sex and age group from escapement samples collected from the Arolik River, Alaska.

Year	Sample Dates	Sample Size	Sex		Age Class						
					Unknown	1.2	1.3	1.4	1.5	2.2	2.4
1994	8/22-8/24	45	M	Mean Length	794	795	852	900			
				Std. Error	29.97	35.00	13.21				
				Range	560-950	760-830	810-900	900-900			
				Sample Size	11	2	6	1	0	0	0
			F	Mean Length	792	750	797	855	840	905	855
				Std. Error	31.51	52.39	21.59	16.07			
				Range	695-900	555-865	670-875	830-885	840-840	905-905	855-855
				Sample Size	6	5	8	3	1	1	1
1995	7/20-7/23	17	M	Mean Length	850		855	937			
				Std. Error				20.88			
				Range	850-850		855-855	840-975			
				Sample Size	1	0	1	6	0	0	0
			F	Mean Length	912			905			
				Std. Error	14.24			9.04			
				Range	895-940			870-935			
				Sample Size	3	0	0	6	0	0	0
1996	7/25-8/29	15	M	Mean Length			755	857	1035		
				Std. Error				45.57			
				Range			755-755	755-970	1035-1035		
				Sample Size	0	0	1	5	1	0	0
			F	Mean Length	842			880	910		
				Std. Error	27.50			0.00	12.42		
				Range	815-870			880-880	880-935		
				Sample Size	2	0	0	2	4	0	0
Grand Total [1]		77	M	Mean Length	822	795	821	898	1035		
				Range	560-950	760-830	755-900	755-975	1035-1035		
				Sample Size	12	2	8	12	1	0	0
			F	Mean Length	849	750	797	880	875	905	855
				Range	695-940	555-865	670-875	830-935	840-935	905-905	855-855
				Sample Size	11	5	8	11	5	1	1

[1] Grand total mean lengths are simple averages of the season mean lengths.

Table 2. Mean lengths (mm) of chinook salmon by sex and age group from escapement samples collected from Gechiak Creek, Alaska.

Year	Sample Dates	Sample Size	Sex		Age Class					
					Unknown	1.2	1.3	1.4	2.2	2.4
1994	8/30-9/2	18	M	Mean Length	910	548	718			985
				Std. Error		77.15	89.27			
				Range	910-910	395-640	590-890			985-985
				Sample Size	1	3	3	0	0	1
			F	Mean Length	610	830	828	872		905
				Std. Error			30.44	17.50		
				Range	610-610	830-830	780-945	855-890		905-905
				Sample Size	1	1	5	2	0	1
1995	8/13-8/15	5	M	Mean Length	580			945	545	
				Std. Error						
				Range	580-580			945-945	545-545	
				Sample Size	1	0	0	1	1	0
			F	Mean Length				905		
				Std. Error				20.00		
				Range				885-925		
				Sample Size	0	0	0	2	0	0
Grand Total [1]		23	M	Mean Length	745	548	718	945	545	985
				Range	580-910	395-640	590-890	945-945	545-545	985-985
				Sample Size	2	3	3	1	1	1
			F	Mean Length	610	830	828	889		905
				Range	610-610	830-830	780-945	855-925		905-905
				Sample Size	1	1	5	4	0	1

[1] Grand total mean lengths are simple averages of the season mean lengths.

Table 3. Mean lengths (mm) of chinook salmon by sex and age group from escapement samples collected from the North Fork Goodnews River, Alaska.

Year	Sample Dates	Sample Size	Sex		Age Class									
					Unknown	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4
1992	8/6-8/20	233	M	Mean Length	768	512	639	763	884		607	579	800	970
				Std. Error	37.17	22.92	27.65	14.47	17.75		67.66	57.82	53.37	
				Range	500-1040	375-660	460-940	575-1070	650-1030		520-740	425-690	690-1070	970-970
				Sample Size	17	12	24	45	24	0	3	4	7	1
			F	Mean Length	866	590	760	864	869	907			775	886
				Std. Error	7.82		140.00	9.64	6.63	19.22			75.00	17.12
				Range	810-905	590-590	620-900	780-955	800-1025	885-945			700-850	815-960
				Sample Size	16	1	2	20	44	3	0	0	2	8
1994	8/8-8/16	88 [2]	M	Mean Length	826	540	686	795	920	935			920	940
				Std. Error	41.03		26.35	23.00	32.20					
				Range	655-935	540-540	635-830	640-1000	855-1035	935-935			920-920	940-940
				Sample Size	7	1	7	14	6	1	0	0	1	1
			F	Mean Length	856		817	788	852	860				
				Std. Error	18.21		2.50	17.52	12.27	7.64				
				Range	705-970		815-820	650-855	740-925	845-870				
				Sample Size	14	0	2	12	18	3	0	0	0	0
1995	7/16-8/26	89 [2]	M	Mean Length	784		661	713	927					
				Std. Error	29.66		25.19	28.13	10.90					
				Range	716-954		611-748	657-840	823-1044					
				Sample Size	8	0	5	6	26	0	0	0	0	0
			F	Mean Length	841		739	864	869	967				
				Std. Error	19.03		80.50	38.00	8.25					
				Range	754-928		659-820	826-902	798-971	967-967				
				Sample Size	8	0	2	2	30	1	0	0	0	0
1996	8/5-8/20	100	M	Mean Length	735		594	757	861	943				
				Std. Error	100.09		19.68	10.55	21.86	34.86				
				Range	478-989		539-632	643-865	707-1015	855-1052				
				Sample Size	5	0	4	29	18	5	0	0	0	0
			F	Mean Length	774			757	858	884				
				Std. Error				21.27	8.26	21.00				
				Range	774-774			697-816	778-930	813-968				
				Sample Size	1	0	0	5	25	8	0	0	0	0

-- continued --

Table 3. Mean lengths (mm) of chinook salmon by sex and age group from escapement samples collected from the North Fork Goodnews River, Alaska (page 2 of 2).

Year	Sample Dates	Sample Size	Sex		Age Class									
					Unknown	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4
Grand Total [1]		510 [2]	M	Mean Length	778	526	645	757	898	939	607	579	860	955
				Range	478-1040	375-660	460-940	575-1070	650-1044	855-1052	520-740	425-690	690-1070	940-970
				Sample Size	37	13	40	94	74	6	3	4	8	2
			F	Mean Length	834	590	772	818	862	905			775	886
				Range	705-970	590-590	620-900	650-955	740-1025	813-968			700-850	815-960
				Sample Size	39	1	6	39	117	15	0	0	2	8

[1] Grand total mean lengths are simple averages of the season mean lengths.

[2] Sample sizes do not equal number of fish due to samples of unknown sex or unknown length.

Table 4. Mean lengths (mm) of chinook salmon by sex and age group from escapement samples collected from the Kanektok River, Alaska.

Year	Sample Dates	Sample Size	Sex		Age Class									
					Unknown	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4
1992	7/30-8/21	243 [2]	M	Mean Length	825	548	611	772	892	939		675	800	942
				Std. Error	33.79	6.50	32.31	15.91	9.49			51.93	80.50	
				Range	552-1025	542-555	505-881	620-960	610-1021	939-939		532-913	720-881	942-942
				Sample Size	15	2	11	32	73	1	0	6	2	1
			F	Mean Length	848		600	851	852	902		529	845	859
				Std. Error	25.17		47.50	16.36	8.15	12.30		46.00		16.00
				Range	655-938		553-648	767-922	602-962	876-935		483-575	845-845	843-875
				Sample Size	13	0	2	10	59	4	0	2	1	2
1993	7/29-8/10	256	M	Mean Length	831		605	771	888	987			730	
				Std. Error	26.69		36.40	11.36	10.28	34.99				
				Range	655-965		500-860	640-970	670-1050	880-1100			730-730	
				Sample Size	13	0	10	53	56	6	0	0	1	0
			F	Mean Length	825		593	758	873	904		642		825
				Std. Error	18.59		58.05	15.12	6.43	17.84				
				Range	690-940		513-765	625-890	745-1030	800-970		642-642		825-825
				Sample Size	13	0	4	25	64	9	0	1	0	1
1994	8/8-8/16	365 [2]	M	Mean Length	823		742	770	877		550	780	867	852
				Std. Error	13.18		25.53	8.51	14.49				18.28	35.48
				Range	550-1055		565-920	595-935	740-1005		550-550	780-780	810-925	625-1010
				Sample Size	71	0	16	77	25	0	1	1	5	9
			F	Mean Length	849		797	828	851	857	595		857	854
				Std. Error	7.84		2.50	11.96	6.52	8.33			12.49	6.78
				Range	700-950		795-800	650-925	760-935	840-865	595-595		820-890	795-895
				Sample Size	46	0	2	24	44	3	1	0	6	18
1995	7/28-8/15	150	M	Mean Length	841		550	700	913					
				Std. Error	45.82		16.95	20.15	9.34					
				Range	519-1033		516-570	648-787	740-1016					
				Sample Size	14	0	3	6	48	0	0	0	0	0
			F	Mean Length	843		581	911	882	874				851
				Std. Error	24.86		38.00	19.78	7.61	5.24				19.00
				Range	631-947		543-619	882-949	638-987	864-882				832-870
				Sample Size	15	0	2	3	54	3	0	0	0	2

-- continued --

Table 4. Mean lengths (mm) of chinook salmon by sex and age group from escapement samples collected from the Kanektok River, Alaska (page 2 of 2).

Year	Sample Dates	Sample Size	Sex		Age Class									
					Unknown	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4
1996	7/28-8/12	150	M	Mean Length	912		523	758	907	950			695	739
				Std. Error	36.87		22.59	15.93	18.08	30.49			39.50	
				Range	740-1005		453-605	510-890	760-1020	738-1042			656-735	739-739
				Sample Size	6	0	6	33	18	9	0	0	2	1
			F	Mean Length	857			829	861	917				865
				Std. Error	14.37			28.98	7.52	11.36				5.00
				Range	750-942			785-907	770-965	837-980				860-870
				Sample Size	15	0	0	4	39	15	0	0	0	2
Grand Total [1]		1,164 [2]	M	Mean Length	846	548	606	754	895	959	550	728	773	844
				Range	519-1055	542-555	453-920	510-970	610-1050	738-1100	550-550	532-913	656-925	625-1010
				Sample Size	119	2	46	201	220	16	1	7	10	11
			F	Mean Length	844		643	835	864	891	595	586	851	851
				Range	631-950		513-800	625-949	602-1030	800-980	595-595	483-642	820-890	795-895
				Sample Size	102	0	10	66	260	34	1	3	7	25

[1] Grand total mean lengths are simple averages of the season mean lengths.

[2] Sample sizes do not equal number of fish due to samples of unknown sex or unknown length.

Table 5. Mean lengths (mm) of chinook salmon by sex and age group from escapement samples collected from the Togiak River, Alaska.

Year	Sample Dates	Sample Size	Sex		Age Class							
					Unknown	1.1	1.2	1.3	1.4	1.5	2.3	2.4
1992	8/17	7	M	Mean Length	950				860	965		
				Std. Error								
				Range	950-950				860-860	965-965		
				Sample Size	1	0	0	0	1	1	0	0
			F	Mean Length				840	857		900	
				Std. Error					32.50			
				Range				840-840	825-890		900-900	
				Sample Size	0	0	0	1	2	0	1	0
1994	8/22-8/23	108	M	Mean Length	711	547	704	779	842			
				Std. Error	34.27	23.94	67.70	21.19	27.83			
				Range	585-900	510-610	525-930	615-890	760-940			
				Sample Size	9	4	5	14	6	0	0	0
			F	Mean Length	871		780	843	858	880	910	855
				Std. Error	11.47		35.59	12.84	15.31	36.69		
				Range	800-1010		720-860	760-965	760-955	820-955	910-910	855-855
				Sample Size	22	0	4	20	19	3	1	1
Grand Total [1]		115	M	Mean Length	831	547	704	779	851	965		
				Range	585-950	510-610	525-930	615-890	760-940	965-965		
				Sample Size	10	4	5	14	7	1	0	0
			F	Mean Length	871		780	842	858	880	905	855
				Range	800-1010		720-860	760-965	760-955	820-955	900-910	855-855
				Sample Size	22	0	4	21	21	3	2	1

[1] Grand total mean lengths are simple averages of the season mean lengths.

The Osviak River was sampled on 22 August 1996. Four chinook salmon carcasses were sampled. Two were males and two were females. The two males were ages 1.3 (length 670 mm) and 1.4 (length 860 mm). The two females were both age 1.4 and 860 mm in length.

Pungokepuk Creek was sampled on 24 August 1995. Two chinook salmon carcasses were sampled. One was a male and one was a female. The male was age 1.3 and 655 mm in length and the female was age 1.4 and 880 mm in length.

DISCUSSION AND RECOMMENDATIONS

Although sample sizes in each river each year (N = 2 to 365) were less than the desired goal of 460, this collection of chinook salmon escapement samples provides the only recent published ASL composition data for these waters. Run timing and water levels may severely affect the availability of salmon carcasses for sampling. In addition, fisheries sampling trips are short in duration which limits the time on a river to collect samples and regular field responsibilities of the River Ranger Program may restrict their time available for this sampling effort. Work schedules for field crews need to be flexible enough for the crews to concentrate on escapement sampling when carcasses are most plentiful which can generally be expected to begin in early August and peak after mid-August for most western Alaska rivers.

Predominant scale ages found in these samples (1.3 and 1.4) match ages for other Bristol and Kuskokwim Bay areas. As determined by ADFG, age 1.3 and 1.4 chinook salmon typically comprise the majority of the escapement into the Nushagak River based on the 1988-1994 average (ADFG 1996) and most chinook salmon return to the Kuskokwim Bay area at age 1.5, 1.4, or 1.3 (Francisco et al. 1995).

Sampling chinook salmon carcasses may bias results towards larger size fish (Dunaway 1997 and Bev Cross, personal communication). Large chinook salmon are easily visible when washed up on gravel bars or in shallow water. Small chinook salmon may blend in with carcasses of chum and sockeye salmon and be missed in the sample. They may be more likely to be carried away by the current, or rot away more quickly. This may cause higher proportions of older age fish and a larger mean length by age group being reported. During sampling of escapement salmon carcasses, all fish should be identified for species to ensure all size ranges of chinook salmon are sampled.

Aging scales from chinook salmon carcasses may also be a source of bias. All salmon resorb their scales to some extent during their migration and spawning progression making it difficult to determine how many circuli or annuli may have been resorbed, or the total age of the fish (Mosher 1969). Salmon carcasses have maximum resorption and it may only be possible to compare data from similar sampling methods. Length at age data from our escapement sampling was considerably higher than length at age data from Kuskokwim Bay rivers documented by ADFG (Molyneaux and Dubois 1996). However, ADFG's samples were collected from weir sites and commercial catches and would have less scale resorption and better represent the true

length at age of the population.

Biases regarding the sex of the individual chinook salmon should also be considered. Males tend to drift downstream in a moribund condition after spawning, while females tend to die near their redds (McPherson et al. 1996). Male chinook salmon may be flushed further downstream and potentially missed during sampling.

As with all capture methods, sampling chinook salmon carcasses may pose some biases. Two aspects that help eliminate carcass sampling biases are to 1) sample all sizes of fish and 2) spread the sample out over a long period of time. Escapement sampling on the Goodnews and Kanektok Rivers meet these criteria and probably have a low bias. However, sampling on the Togiak River and other waters during fisheries sampling trips were of short duration and may add to the bias.

Despite the potential for biases, collecting scales from chinook salmon carcasses may be the only economical method for determining the age composition of the escapement in most rivers. Continuing this data base will become increasingly useful in monitoring the commercial fisheries, ensuring viable spawning escapement, and for evaluating escapement goals. Continuation of this sampling effort is dependent on Togiak Refuge public use survey programs for the Kanektok, Goodnews, and Togiak Rivers and on fishery surveys throughout the Refuge.

Recommendations for future efforts are: (1) efforts should seek to achieve the desired sample size of 460 fish; (2) work schedules for field crews need to be flexible enough for them to concentrate on escapement sampling when carcasses are most plentiful; (3) identifying all salmon carcasses for species to ensure all size ranges of chinook salmon are sampled; (4) dissecting chinook salmon carcasses to determine sex of the fish when in doubt; (5) searching a variety of habitats for carcasses; and (6) efforts should concentrate on rivers with commercial fisheries districts where Refuge staff are present during 1-20 August.

Further recommendations are to address potential biases in the age composition from the carcass samples. Otoliths should be collected to verify scale ages and to determine if scale resorption is a factor in aging the scales. If so, a possible solution is to document the sex and length of the chinook salmon carcasses and use length at age data from the commercial and sport catch and weir and tower monitoring where scale resorption is not likely to have occurred to aportion the ages of the carcass samples.

ACKNOWLEDGMENTS

I thank the Alaska Department of Fish and Game, Sport Fish Division staff in Dillingham and Research and Technical Services in Anchorage, for their assistance in data optical scanning, software and technical assistance.

Thanks to the efforts of A. Felton Jenkins, Patrick Chubb, Jennifer Culbertson, Stephens Harper, Dominic Malenfant, Ronnie Stanley, Kellie Nolan, Josh Pierce, and John Moran for the collection of scales and data from chinook salmon carcasses. A special thanks goes to Robert Doyle who has ensured the large sample sizes on the Kanektok and Togiak Rivers.

REFERENCES

ADFG (Alaska Department of Fish and Game). 1990. Instructions for using sport fish creel survey and biological mark-sense forms, 1990. Division of Sport Fish, Research and Technical Services. Anchorage, Alaska.

ADFG (Alaska Department of Fish and Game). 1996. Alaska Department of Fish and Game Division of Commercial Fisheries Management and Development Annual Management Report - 1995 - Bristol Bay Area. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Bristol Bay Area. Regional Information Report No. 2A96-06. Dillingham, Alaska

Anderson, C. Personal communication. Fisheries Biologist. Alaska Department of Fish and Game. Commercial Fisheries Management and Development. Anchorage, Alaska.

Clutter, R. I. and L. E. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. International Pacific Salmon Fishery Commission, Bulletin 9.

Coggins, L.G. 1994. Precision of ages estimated from scales for rainbow trout in Bristol Bay, Alaska. Alaska Department of Fish and Game, Fisheries Data Series No. 94-26.

Cross, B. Personal communication. Fisheries Biologist. Alaska Department of Fish and Game. Commercial Fisheries Management and Development. Anchorage, Alaska.

Dery, L.M. 1983. Use of laminated plastic to impress fish scales. Progressive Fish Culture, 45(2), April 1983. Pages 87-88.

Dunaway, D. 1997. Review of draft USFWS king escapement report. A memo describing biases relating to sampling escapement chinook salmon. Alaska Department of Fish and Game, Dillingham, Alaska. Dated March 12, 1997.

Francisco, R.K., C. Anderson, C. Burkey Jr., M. Fogarty, D.B. Molyneaux, C. Utermole, and K. Vaught. 1995. Annual management report for the subsistence and commercial fisheries of the Kuskokwim Area, 1994. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, AYK Region. Regional Information Report No. 3A95-15. Anchorage, Alaska.

Heineman, G.M. 1989a. Instructions for using sport fish mark sense diskettes 1989. Alaska Department of Fish and Game, Division of Sport Fish, Research and Technical Services. Anchorage, Alaska.

Heineman, G.M. 1989b. BBX computer program for analysis of biological samples. Revised 3/13/89. Alaska Department of Fish and Game Research and Technical Services Division. Anchorage, Alaska.

Larson, J. Personal communication. Project Leader. U.S. Fish and Wildlife Service. King Salmon Fishery Resource Office. King Salmon, Alaska.

Lisac, M.J. and R. MacDonald. 1995. Age distribution of chinook salmon escapement samples, Togiak National Wildlife Refuge, Alaska, 1994. U.S. Fish and Wildlife Service, Fishery Data Series Number 95-4. Dillingham, Alaska.

Lux, F.E. undated. Age Determination of Fishes (Revised). U.S. Department of Commerce. NOAA, National Marine Fisheries Service. Fishery Leaflet 637. Revision of Lux, F.E. Age Determination of Fishes, USFWS, Fishery Leaflet No. 488.

MacDonald, R. 1996. Age distribution of chinook salmon escapement samples, Togiak National Wildlife Refuge, Alaska, 1995. USFWS, Fishery Data Series Number 96-6. Dillingham, Alaska.

McPherson, S.A., D.R. Bernard, M.S. Kelley, P.A. Milligan, and P. Timpany. 1996. Spawning abundance of chinook salmon in the Taku River in 1995. Alaska Department of Fish and Game, Fishery Data Series Number 96-36, Anchorage, Alaska.

Mosher, K.H. 1969. Identification of Pacific salmon and steelhead trout by scale characteristics. USDOI, U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, XF WC-A 317 1-17 (1969).

Molyneaux, D. and L. Dubois. 1996. Salmon age, sex and length catalog for the Kuskokwim Area, 1995 progress report. Alaska Department of Fish and Game, Regional Information Report Number 3A96-31, Anchorage, Alaska.

Riffe, R. 1994. Pressing Scales. An internal memo describing the performance and procedures of using the hydraulic press for creating acetate scale impressions. Alaska Department of Fish and Game, Dillingham, Alaska. Dated January 14, 1994.

Sokal, R.R., and F.J. Rohlf. 1981. Biometry, the principles of statistics in biological research. Second edition. W.H. Freeman and Company, New York, NY.

APPENDIX A

Appendix Table A1. Sample location, size and data file name for chinook salmon escapement samples collected and analyzed by Togiak NWR, 1992-1996.

River	Number of Fish Sampled	Number of Fish Aged	RTS Data File Number
Arolik River			
1994	45	28	V0880BA4
1995	17	13	V0880BA5
1996	15	13	V0880BC6
Gechiak Creek			
1994	18	16	T1400BA4
1995	5	4	T1400BA5
North Fork Goodnews River			
1992	233	200	V0040BA2
1994	88	66	V0040BA4
1995	89	73 [1]	V0040BA5
1996	100	94	V0040BA6
Kanektok River			
1992	243	213 [1]	V0030BB2
1993	256	230	V0030BE3
1994	365	243 [1]	V0030BC4
1995	150	121	V0030BA5
1996	150	129	V0030BA6
Matogak River			
1996	3	3	T1540BA6
Osviak River			
1996	4	4	T1550BD6
Pungokepuk Creek			
1995	2	2	T1320BA5
Togiak River			
1992	7	6	T0060BB2
1994	108	77	T0060BA4

[1] Sample sizes do not equal those analyzed in report due to unknown sex or unknown length.